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THE MANAGEMENT OF END-USER COMPUTING**

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An Agency Theory View of the Management of End-user Computing

ABSTRACT

The rapid growth in end-user computing (EUC) in organizations and its implications for the degree of centralization of the information services function have led to the need for a theory that will assist in the management of this process. This paper employs microeconomics and, in particular, agency theory to develop a positive model of the growth of EUC. The theory developed here is evaluated using descriptive data from earlier EUC research. The model is shown to possess considerable explanatory power, suggesting that agency theory provides clear insights into the management of computing, and has significant normative implications for the management of computing in organizations.

1. INTRODUCTION

The dramatic decline in the costs of hardware and the trend towards the increased power of microcomputers and minicomputers have enabled significant growth in end-user computing (EUC). This trend has implications not only for the management of EUC but also for the degree of centralization of the Information Systems (IS) function in organizations. Therefore, there has been increased focus on the organizational issues surrounding EUC, as evidenced by senior IS executives' responses in several recent surveys.¹ Management issues related to decentralization of the IS department also ranked high on their list of concerns.

This interest in EUC has resulted in numerous articles in the academic and practitioner literature. The primary thrust of many of these articles is prescriptive and suggests alternative managerial strategies for EUC (Alavi et al. (1987), Gerrity and Rockart (1986), Henderson and Treacy (1985), Munro et al. (1987)). Some studies have analyzed the characteristics of end-users and their tasks (Rivard and Huff (1985), Quillard et al. (1983), Rockart and Flannery (1983)) and how these tasks evolve (Huff et al. (1988)). However, the previous research does not develop positive models, namely those "that provide knowledge about how the world behaves" (Jensen (1983)). A positive model of end-user computing would link the process of its growth to underlying theories of managerial behavior. Robey and Zmud (1989) have recently criticized the EUC literature for not being "grounded in specific theories of organizational behavior." The current paper proposes the use of *agency theory* as a theoretical base and integrative approach within which to understand the EUC phenomenon.

The aims of this paper are to develop a positive model of the growth of EUC in organizations and to study its implications. End-user computing has been defined as "the capability of users to have direct control of their own computing needs" (Davis and Olson

¹ First most important in a list of 22 issues, Arthur Andersen (1986); second most important in a list of 19 issues, Dickson, et al. (1984).

(1985)). This definition of EUC emphasizes the control aspects of the problem which, it will be argued later, are at the heart of the issue. In particular, it highlights the division of control between the end-user departments and the central IS organization.

The reference discipline employed in this paper is microeconomics encompassing agency theory, as originally suggested by Kriebel and Moore (1980). While traditional microeconomics has proven useful in analyzing a large variety of problems, it has not been widely used in analyzing intra-firm managerial control problems due to its assumptions of costless information transfer and of goal congruence of managers within the firm. Agency theory extends the microeconomic approach by relaxing these assumptions and, therefore, is shown to be particularly appropriate for the intra-firm nature of the EUC control problem. The theory developed here has significant normative implications for the management of computing in organizations.

The outline of this paper is as follows. The research problem and approach are presented in Section 2. Section 3 introduces the principal-agent problem in IS within a microeconomic framework and analyzes its impact on the optimal production strategies for information services. In Section 4, the model of EUC is illustrated using independent secondary descriptive data. Managerial implications and concluding remarks are presented in Section 5.

2. THE RESEARCH PROBLEM AND APPROACH

This section begins with an introduction of the research problem -- control of the provision of IS services. Next, the salient features of the traditional microeconomic approach and its shortcomings in analyzing managerial behavior in this context are presented. This is followed by a brief discussion of agency theory, which extends the traditional microeconomic approach to address these deficiencies.

A. Research Problem

Given the nature of the supply of and demand for information services, the organization must determine how the internal provision of information services will be organized so as to maximize the net value of information services. Traditionally, IS activities have been grouped into the following categories: administration, systems development, operations and technical services (Zmud (1984)). Administrative tasks include capacity planning, systems planning, budgeting, and standards development. Systems development activities include in-house software development and maintenance, as well as hardware and packaged software selection. Operations include activities such as job scheduling, hardware maintenance and machine operation, while technical services include database and telecommunications support.²

The focus here is on the *control* issues related to the internal provision of these services. Control means the ability to i) choose the decision initiative to be implemented and ii) to measure the performance of agents and implement a reward structure (Fama and Jensen (1983)). Control issues that govern IS activities include the choice of the organization structure of the IS department, managerial compensation contracts, the decision to mandate that a service be acquired from the central IS group, chargeback systems for information services, and budget allocation mechanisms. The choice of control mechanisms is naturally a major determinant of the effectiveness of IS activities.

The authority to determine how a specific activity is performed is termed here as a *decision right*. Formal approaches recognize that initially all decision rights reside with top management, who may decide to allocate some or all of these rights to IS and end-user departments. Then, the locus of control is determined by the partitioning of decision rights between the different members of the organization. Thus, the control problem may be viewed as determining the optimal partition of these decision rights.

² For the remainder of this paper, operations and technical services will be considered together in one category, operations/technical services.

Decentralized computing, defined here as the transfer of control from centralized IS departments to end-user or functional departments, has continued to grow in scope and in degree (Arthur Andersen (1986)). The decentralization of computing cannot be explained simply by examining the economics of the production of information services. If that were true, one might witness the growth of *distributed computing* as distinguished from *decentralized computing*. Distributed computing is defined as the location of hardware, software and personnel at various sites throughout the organization with the important provision that control decision rights remain vested in a central authority.

An underlying factor in the growth of decentralized computing was the dissatisfaction of users with the centralized environment.³ In theory, it is feasible to develop a centralized plan for the provision of information services wherein all users are satisfied. Yet, this has rarely occurred. It shall be argued below that the dominant factor that resulted in a significant decrease in the likelihood of success of a centralized IS organization is a principal-agent problem. However, before developing this argument, the traditional microeconomics argument is presented to provide a framework with which to build the agency model.

B. The Traditional Microeconomics View

The microeconomics approach to developing positive or descriptive models of a phenomenon assumes net value maximizing behavior. To develop a positive theory of IS management, one would build a model of this process by assuming that practices relating to the management of computing are an outcome of net value maximizing behavior (Silberberg (1978)). Thus, one would assume that the goal of the firm would be to maximize the net value of information services to the organization and derive, for example, the testable implication that in the early years of computing, firms centralized computing

³ See Section 4 for a number of empirical examples of this phenomenon observed by EUC researchers.

services to exploit economies of scale in hardware. These hypotheses of managerial behavior could then be tested against empirical data to determine the validity of the model.

One traditional microeconomic approach has been to assume a number of ideal conditions, under which it has been shown that optimizing behavior on the parts of individuals and firms under pure-competition leads to a Pareto-optimal social outcome, i.e., one where no other allocation makes all parties concerned at least as well off and one or more parties better off (Hirshleifer (1980)). It implies that, under certain conditions, social welfare is maximized simply as a result of the individual economic players acting out of self-interest. More formally, a Pareto-optimal allocation results in a competitive equilibrium implying efficiency among consumers in the allocation of consumption goods, efficiency among resource owners in the provision of resources for productive uses, and efficiency among firms in the conversion of resources into consumable goods.

While the above discussion applies to economic actors in a competitive market, it can also be extended to apply within a firm. In the context of the management of IS, the parallel situation would be the creation of a market for information services within a firm (perhaps even including economic actors outside the firm). Thus, one could consider a situation where individual departments would be allowed to act as consumers or suppliers of information services. If the net value of information services to the organization were maximized using such an approach, the task facing the firm would be the creation and maintenance of such a market.

However, several factors may cause a market failure where social welfare is not maximized in a market situation. These include the presence of market power and the existence of externalities. Market power is usually seen as monopoly or monopsony power. Externalities occur when the actions of an economic agent affect the interests of other agents in a way not captured by market prices. Both of these factors limit the applicability of the traditional microeconomics results and may lead to situations where a pure market-based approach is inadequate. Vertical integration (corresponding to decentralized

computing) is often cited as a possible solution to these problems, since it allows the internalization of externalities and limits market power. In this paper, it is argued that i) both market power and externalities are present in the intra-firm IS context and that ii) market power is exercised and actions that cause externalities are taken because of problems due to the *agency relationships* (discussed below) among the actors within a firm.

C. The Theory of Agency

An agency relationship can be said to occur whenever one party depends on the actions of another party. More formally, Jensen and Meckling (1976) define an agency relationship as "... a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent." In an organizational context, a firm hires employees (agents) in part to exploit economies of specialization. Yet, these employees often act in a manner that is inconsistent with maximizing the welfare of the firm. Agency theory argues that this occurs because:

- a) the goals of the principal and the agent are often inconsistent with one another ("goal incongruence"), and
- b) the principal cannot perfectly and costlessly monitor the *actions* and the *information* of the agent ("information asymmetries").

Since agents are usually better informed than their principals about their tasks, organizations would do better if all information could be shared at zero cost, or if there was no divergence between the goals of the principals and the agents. The economic loss that occurs due to the absence of such optimal conditions is called the *agency cost*. The components of agency costs are: *monitoring costs* expended by the principal to observe the agent, *bonding costs* incurred by the agent to make his or her services more attractive, and *residual loss*, which are the opportunity costs borne by the principal due to the difference in outcomes that would obtain between the principal's and agent's execution of the task (Jensen and Meckling (1976)). An implication of the assumption of net value

maximization and the existence of agency costs is that the principal seeks to minimize agency costs through the use of control mechanisms. The primary control mechanisms in organizations are the performance measurement and evaluation system, the reward and punishment system, and the system for assigning decision rights among participants in the organization (Jensen (1983)).

In the case of costless information transfer and the absence of agency costs, as is assumed by the traditional microeconomics approach, the control problem is inconsequential. One can simply assume that all information that a central planner requires to make a decision and that is possessed by other actors within the firm can be acquired costlessly. Further, since all actors behave in a manner that is consistent with maximizing the value of the firm, no control mechanisms are required to ensure the consistency of managerial behavior with the goals of the firm. However, in a realistic setting, the control problem assumes importance because of the existence of information asymmetries and goal incongruencies and the resulting agency costs.

Eisenhardt (1989) has articulated the usefulness of agency theory in analyzing managerial problems characterized by goal conflicts, outcome uncertainty, and unprogrammed or team-oriented tasks. Many IS activities fit this description, and it has been suggested that a large number of organizational problems in the management of IS can be analyzed successfully in an agency context (Gurbaxani and Kemerer (1989), Robey and Zmud (1989)). The design of effective control mechanisms for IS activities is particularly difficult, since the agency relationship occurs in a dynamic, rapidly changing environment and management practices have little time to stabilize (Nolan (1979), Gurbaxani and Mendelson (1989)). In this paper, the focus is on the impact of agency costs on the organization of the internal provision of information services.⁴ Specifically

⁴ An alternative approach would be transaction cost economics, an approach with similarities to agency theory in its emphasis on information and uncertainty (Williamson (1985)). Eisenhardt (1989) notes agency theory's inclusion of the notions of risk aversion and information as a commodity as distinctions with transaction cost economics. Moreover, transaction cost theory's primary (though not exclusive) focus is on costs incurred between firms trading in a market rather than within firms, while agency theory focuses on

examined are the impact of agency costs on the growth of EUC and the implications for the degree of centralization of the information services functions.

3. AN AGENCY MODEL OF INFORMATION SERVICES

The key issues that arise in an agent-theoretic analysis of the management of IS are an identification of the economic actors and their objectives, an analysis of how these objectives result in conflict, and an analysis of the nature of the resulting organizational costs. These issues must be considered in conjunction with the microeconomic and technological characteristics of the IS environment to determine the optimal strategies for the management of IS resources.

A. The Agency Structure of Traditional Computing in Organizations

In order to provide a model of current end-user computing, it is helpful to begin with a brief discussion of traditional computing in organizations to show the origins of EUC. The level of analysis is the department and three types of economic units will be relevant: top management, the centralized IS department, and end-user departments (see Figure 1).⁵

There are three resulting principal-agent relationships. In two of these relationships, the principal is top management and the agents are the functional departments and the IS department. In the third relationship, each end-user department is a principal and the IS department is the agent.⁶ The objectives of each of these actors are

intra-firm relationships. Thus, transactions cost economics seems most appropriate for the study of the external provision of information services, while agency theory is more applicable to within firm transactions.

⁵ Consistent with this approach, the behavioral assumption is made that all economic units act out of self-interest. While there are obvious divergences between the goals of individual actors within each of the three units and the goals of their managers, these are of secondary importance in the current analysis. Thus, for the purposes of exposition, the idealized assumptions are made that top management attempts to maximize the value of the firm, that end-users within a functional department attempt to maximize the "objective function" of the department head and that the central IS staff attempts to maximize the "objective function" of the IS manager. Henderson (1987) uses a similar approach in studying the IS design environment.

⁶ With the possible exception of organizations whose primary external product is information services, information systems are a support or staff function and, therefore, the IS department "works for," in an agency sense, the end-user departments, and not the other way around.

considered in turn, focusing on the IS aspects of the principal-agent relationships. It will be argued in Section 3.B that the individual objectives of each of these actors can be in conflict with one another and result in agency costs. However, before coming to that conclusion, it is useful to examine how this structure for providing information services within the organization came about.

When computing was first introduced into organizations, most end-users and top management, specifically, were unfamiliar with the technology. This resulted in top management creating IS departments and hiring specialists in the production of information services. For the same reason, most decision rights related to the management of computing were allocated to the IS department. The decision to centralize computing was driven primarily by the costs of computing.⁷ The demand generated by any single end-user group often did not justify such a large investment. Thus, the demands of various end-user groups had to be aggregated to justify the investment. The decision rights related to hardware and software selection were typically located in the IS department. Applications software was developed almost exclusively by professionals who were located in the IS department. Since individual end-user departments were uncertain of their future demands for software services, the appropriate strategy for the location of software professionals was to centralize the programming function since this would simplify the management of these professionals.

Therefore, the centralization of computing was a result of organizations seeking to exploit economies of scale and of specialization that were warranted by the high costs of computing. Due to supply-side considerations in that time, the costs of production outweighed any other costs in determining the strategy for the provision of information services. The net result of the centralization of computing was that computing became a public good. In the case of public goods, the decision problem is to find the solution that

⁷ In particular, there were significant economies of scale in hardware technologies, as is embodied in Grosch's law (Mendelson (1987)). Moreover, not only were the unit costs of computing high, but hardware capacity could only be purchased in large, discrete chunks.

maximizes public welfare over a large set of diverse users, and the resulting social optimum may not be any user group's local optimum. This idea is critical to the discussion below of the impacts of agency costs on the provision of information services.

B. Market Failures in Organizational Computing Due to Agency

As the unit costs of computing decreased over time, and as minicomputer and microcomputer technology became available, decentralized computing became feasible, as will be seen below. However, the changing economics of information systems supply are a necessary but not sufficient condition for decentralized computing (as opposed to merely distributed computing). To see this, the nature of agency costs in a centralized environment are discussed below.

B.1. IS department as an agent of top management

In the traditional environment, top management relied upon IS specialists as their agents to provide IS services. These agents were typically organized into one centralized department due to the economies of scale and specialization noted above. However, this agency relationship introduces costs to the organization through goal incongruencies and information asymmetries.

While net value maximization of information services is often the stated intent of IS managers, their actual behavior patterns sometimes suggest that their "objective function" may be quite different. For example, the salaries of these managers is often related to the scale of the operation, inducing them to indulge in so-called "empire building." A related cost arises because of the value managers place on the control of a resource that may increase their political power within the organization. Another problem is termed the "asymmetric cost" problem (Mendelson (1990)). Here, managers often make sub-optimal decisions because the cost of the decision to the manager may be quite different than that incurred by the firm. For example, a manager's evaluation is sometimes based on the quality of services provided rather than on its cost effectiveness. This is often stated in the

practitioner literature as "No one ever got fired for buying IBM." This is an example of the risk-averse nature of the IS manager-agent. IS managers also often suffer from the "professional syndrome" (Mendelson (1990)), wherein they have incentives to acquire the newest hardware and software technologies with insufficient regard for cost justification. This is consistent with maximizing behavior of the IS professional whose market value is partly determined by his familiarity with new technologies.

The optimal allocation of information services typically requires that the marginal value of information services to a division equal the marginal cost of providing these services (Hirshleifer (1980)). If information transfer were costless, one could assume that the IS department possessed both the cost and value information required to implement such an allocation. Thus, information asymmetries would not be an issue. Furthermore, since their actions would be completely known to top management, the IS department could be expected to maximize the net value of information services to the firm.

However, the existence of asymmetric information precludes such a solution. The primary information asymmetry in the IS context is that knowledge of the value of a given IS task is almost always possessed by the end-user, while information about the execution of the task is possessed by the IS department. This information asymmetry also extends to top management, who are neither completely aware of the value of information generated by IS activities to the end-user departments nor of the cost and technological information possessed by the IS department. Thus, top management is faced with the problem of constructing a control system that will maximize the net value of information services to the firm while taking into account the existence of these information asymmetries. The control problem is therefore of considerable importance.

Top management traditionally imposed one of two control structures: a profit center approach or a cost center approach. In a profit center, the performance of the IS manager is measured by the magnitude of profits that he or she generates, while in the case of a cost center, the performance metrics are related to adherence to budgets or by

comparison with "standard costs." Each of these creates very different sets of incentives for the IS manager. The profit center encourages efficiency in the production of information services, but also creates incentives for the IS manager to act as a monopolist to increase profits. This, in turn, raises the likelihood that the prices of computing services will be higher than optimal. The cost center, on the other hand, does not create incentives for higher prices, but neither does it encourage efficient production.⁸

In both of these control structures, the welfare of the organization is reduced by the agency costs that result from the actions of the IS manager. When the IS department is set up as a cost center, the costs result from the inefficient production of information services. These costs are manifested as delays in operations, backlogs in software development, and higher total costs (as distinguished from unit costs) for information services. In the case of a profit center, such costs are incurred primarily as higher monopoly prices rather than as free-market prices for services.

As the costs of computing continued to decrease over time, and as minicomputer technology became a feasible option, the decision not to mandate that all computing services be acquired from central IS meant that individual end-user departments were given the right to implement decentralized computing. The fact that decentralized computing was implemented by some end-users -- even though it was initially more expensive than centralized computing services due to the fixed costs and lost economies of scale and specialization -- strongly suggests that these end-users were incurring costs beyond those seen in accounting statements. This suggests that end-user departments exercised this option to minimize the agency costs resulting from the self-interested behavior of the IS department. Decentralized computing is therefore an effective means of limiting the market power of IS departments.

⁸ For a more detailed discussion of these issues, see Gurbaxani and Kemerer (1989).

B.2 User department as an agent of top management

Analogous to the IS department's role as an agent to the firm, each end-user or functional department also acts as an agent (Figure 1). Therefore, their behavior also reflects goal incongruencies and information asymmetries in their relationship with the top management principal. The discussion here, however, will be limited to the effect of these factors on the allocation of IS resources within the firm.

Decisions that maximize the net value of information services to the firm may not be locally optimal, that is, they might not maximize the net value of information services to the individual end-user departments. End-users may be dissatisfied with resource allocation decisions. For example, in a mainframe acquisition decision where there are many possible end-users, each set of end-users may prefer a different type of machine. In the case where there is insufficient demand to justify the purchase of more than one machine, only a subset of end-users will receive the machine of first choice, and others will have to make do with a lower ranking choice.⁹ Similar situations arise in the acquisition of software packages as well.

The analogous situation exists in the case of a software development task. The globally optimal specifications for such a task may be an outcome of meeting the demands of numerous end-user groups. Individual end-user groups would prefer customized applications that, in all likelihood, would also have better performance, since they would not be constrained by the requirements of other end-users. Moreover, end-users whose application development requests are queued behind others of higher value to the organization incur waiting costs.

End-user departments also have incentives that encourage them to control their own information. There are several possible reasons for this. The possession of information that is of significant value to the firm often results in increased power to the

⁹ Note that information systems managers may also have their own preferences that are usually driven by a desire to maximize their own market value by developing expertise on particular machine types.

owner of the information. Another reason may be that the information may allow top management to monitor the performance of an end-user department more closely, a possibly undesirable situation for the end-user.

In all of the above situations, undoubtedly some end-user departments could be made better off if the resource allocation decisions were modified in their favor. From an individual end-user department's perspective, they are incurring the costs of externalities imposed by others. Therefore, the end-users now perceive that they can increase their welfare by biasing the information they provide the IS department to increase the likelihood of a more favorable outcome. For example, an end-user may request a higher priority on a timesharing machine than is really warranted by the task or may demand a more powerful personal computer than the one that is the most cost-effective. In such cases, the cost imposed on other end-users stems from a reduction in resources available to them. Since end-users are believed to be acting out of self-interest, they are likely to do so. Of course, they are subject to monitoring by top management that limits the amount of bias in information that they provide. However, monitoring is rarely perfect, and indulging in monitoring activities also results in monitoring costs. The net result is that resource allocation schemes that are in some part dependent on the disclosure of information by agents, are unlikely to be very successful in practice. The challenge facing the organization is to develop a control strategy that aligns the self-interest of agents with the interests of the firm.

B.3 IS department as an agent of end-user departments

The third and final agency relationship, consistent with the IS department being a "staff" as opposed to "line" function in most organizations, is that of the centralized IS department acting as an agent for an end-user department. This relationship also provides for a strong additional source of conflict within the organization. The IS department is effectively the agent of multiple principals (i.e., the top management principal and the end-user principal) whose goals may not converge, as has already been discussed in Section B.2.

Added to this may be the IS department's own agenda (the potential conflict with top management having been discussed in Section B.1). Therefore, conflict between the IS department and an end-user department can come about because a) the IS department is trying to act as an agent for top management and, therefore, may not act in accordance with the desired behavior of the self-interested end-user, and/or b) the IS department is itself engaging in self-interested behavior at the expense of the user department.

There are several forms that these goal incongruencies may take in the IS context. Assuming that the IS department is acting on behalf of the organization, then they will be providing software systems and hardware services that meet the needs of the entire organization, not just an individual end-user department. Therefore, a decision that IS may make on behalf of the organization may be sub-optimal for any given department. In particular, the IS department will engage in activities to promote the long-term computing environment serving a variety of end-users. Therefore, any particular end-user will bear additional costs, including delay costs and integration costs, because they are using shared resources. Another aspect to this shared resource phenomenon is that it may appear to be a public good to the end-user. Given self-interested behavior on the part of the end-user, it is expected that they will tend to over-consume public goods, that is, use more of the IS resource than might be globally optimal for the organization, if the control mechanisms do not insure that the end-user bears the costs of such consumption.

Of course, the IS department may not always act in accordance with what the top management-principal may desire either. Given the difficulty in assessing the value of IS services, many organizations may treat it as a "utility," where the IS department management is evaluated essentially on the ability to deliver a consistent quality of service. This might be implemented by metrics such as machine or network uptime, or low levels of end-user problem reports. In this type of environment, IS department management can become very risk averse, as changes may involve disruptions in service levels. Therefore, any end-user's desire for applications or technologies that differ from past approaches may

be discouraged. This phenomenon is particularly relevant in IS services due to the rapid rate of technological change in this area.

In summary, conflict between the end-user-principal and the IS department-agent can develop from either the IS department role in representing its top management principal or due to the goals of the IS department itself.

C. Conclusions

Given the above discussion, a model of the provision of information services must incorporate the behavioral assumptions that the goals of principals and agents may diverge and that agents act out of self-interest. It should also recognize that information transfer is costly, and moreover, it cannot be presumed that an agent will be willing to reveal private information if such revelation is inconsistent with his or her goals.

Based on the above agency model of IS provision, there exists an essential tension between the centralization and decentralization of IS services. Existing centralized IS departments will prefer the status quo, in part to maximize their own welfare. End-users will desire greater autonomy over their computing, in part in order to avoid the externalities and agency costs which arise in the centralized solution. Into this environment comes the technical feasibility of end-user computing. This provides an option for end-users to provide at least some of their own IS services. That this option has been acted upon in practice suggests support for the agency model. This idea is explored further in the next section.

4. AGENCY THEORY PROPOSITIONS AND EMPIRICAL EVIDENCE

A. Introduction

The preceding section introduced an agency model of EUC. Following the secondary data approach of Swanson (1989), a number of propositions are generated from the model and are compared with observations from previous independent empirical EUC research. The agency model is applied to major activities in each of Zmud's (1984)

categories of IS activities: i) systems development, ii) administration, and iii) operations/technical services. It is shown that the predictions of the agency model are consistent with the results obtained by the empirical research.

B. Systems Development

A number of differences are apparent between traditional systems development, where the IS department agent develops systems at the request of the end-user principal, and EUC, where end-users develop their own systems. These differences relate to the cost of building systems, the methodology of systems development, and the quality of systems. The agency theory model, drawing on the constructs of monitoring costs, information asymmetries, and risk aversion provides an explanation of these differences.

Because of the agency relationship, many systems development activities are not easily observed by the end-user principal. Therefore, the principal will either remain unaware of these activities or will expend monitoring costs (in the form of adding a user to the project team, for example) to better observe IS. Consider the following proposition:

P1: Information asymmetries and high monitoring costs for the end-user principal will tend to increase the cost of IS-developed systems to the end-user.

For example, IS activities such as infrastructure building and integration with other systems can be observed only imperfectly by users. This is a major reason why naive users, whose only experience with systems development may be small, self-developed personal systems, feel that IS costs are too large (Cash, McFarlan and McKenney 1988). In order for end-users to have full information, higher monitoring costs are required, typically in the form of user members on the project team. Relative to this option, EUC development is often attractive. Moreover, even when end-users observe these activities, they often do not value them even when they may be of long term value to the firm. A typical user response is noted by Benson in his study of EUC:

A number of acquisitions have been justified on the basis that development costs, including hardware, were less than software development costs for the mainframe. (Benson (1983), p. 40)

Accounting systems may also contribute to these information asymmetries and cost perceptions. All of the IS costs are typically charged back to the end-user, often in ways that unfairly apportion fixed costs and/or are set at a rate simply to balance the IS budget (Nolan (1977)). An example of such an accounting calculation is noted by Rivard and Huff:

I wrote down the time for developing this particular application: 40 hours. DP would have taken 8 hours just to cost it out and would have charged me \$41.50 an hour to do so." (Rivard and Huff (1988), p. 559)

The cost of deriving the estimate is also a form of monitoring cost for the principal. Even if chargeback is done appropriately, the calculation of the relative costs of IS versus EUC solutions may be difficult due to the typically uncounted opportunity costs of having end-users become amateur systems developers (Hurst (1987)).

Thus the costs of maintaining the agency relationship, coupled with the difficulty in apportioning fixed costs, make IS-developed systems generally appear more expensive than the EUC alternative. Of course, in some cases, IS-development is truly more expensive, particularly on very small systems, due in part, to the costs of working with a shared resource. However, the true net cost may be difficult to determine, given that the high monitoring costs may be offset by the uncounted opportunity costs.

A second systems development proposition relates to the methodology of building systems. In particular, users appear to prefer methodologies such as prototyping, while the central IS department prefers using the more formal systems development life cycle approach. The following proposition offers an explanation for this observation:

P2: Risk aversion on the part of the IS agent will make IS prefer input-based, rather than outcome-based, control strategies.

Traditionally, large systems have been developed using the systems development life cycle (SDLC), a process designed to initially elicit system requirements from end-users, and then to build systems in a carefully planned series of sequential stages that emphasize system validity, correctness and maintainability, rather than speed of development. An alternative approach is prototyping, which allows shorter lead times for the delivery of a

limited set of functionality. In prototyping, development work continues until the user is satisfied. Thus, prototyping is essentially an outcome-based control strategy, while the systems development life cycle, with its extensive task checklists, is essentially an input, or behavior-based approach (Ouchi (1979), Eisenhardt (1985)). Agency theory would predict that the risk-averse agent (central IS) would prefer a behavior-based approach, since the outcome-based approach entails greater risk. Conversely, the end-user principal, who cannot perfectly monitor the agent's behavior, would prefer an outcome-based approach.

In fact, these preferences are observed in practice. For example, Rockart and Flannery note,

For a significant portion of their new applications, users find the tools, methods, and processes adhered to by the information systems organization as entirely inappropriate. (Rockart and Flannery (1986), p. 288)

In addition, while end-users are participants in most phases of the systems development life cycle, they are rarely in control of it. In large mainframe environments, often the critical issues were perceived to be outside the range of the user's expertise, therefore, IS staff were invariably placed in charge of projects. This control structure is still typical today, unnecessarily so in the minds of some end-users. As noted by Rivard and Huff,

UDA [user developed applications] also has the potential of making application development a more flexible process, so users can readily adapt their applications when the need arises. (Rivard and Huff (1984), p. 40)

Due to the ease of making modifications, particularly in the early stages of a prototyped system, end-users may perceive that they will retain more control over the system and its continuing enhancement. This serves as further incentive against the life cycle approach.

Of course, the actual evolution of such projects in reality, differs from this ideal. Note that the direct value of an applications project is derived only by the end-user(s) who requested it. On the other hand, the costs of maintaining it are often incurred by the IS department, even when the user has developed the system (Scheler (1989)). Unless it remains standalone, a quickly prototyped system is likely to result in increased future maintenance costs to the IS department due to the typical lack of upfront design.

However, the benefits of the shorter development time accrue primarily to the end-user. Therefore, it is predictable that IS would prefer to use development approaches that are believed to ease future maintenance. This risk aversion on the part of IS has been noted by Guimaraes (1984, p.6): "MIS departments tend to shy away from user development requests involving ill-defined, unstructured, or volatile requirements." Of course, it is exactly these types of systems for which prototyping is recommended (Davis and Olson, (1985)).

In addition, the use of the systems development life cycle is often perceived by the IS department as necessary in order to determine the impact of new systems on the existing base, or in order to integrate the new systems with older applications. Prototyping methodologies, while delivering new functionality to the user expeditiously, tend to do so by ignoring or delaying activities such as integration. Moreover, end-users want their applications developed in the most rapid and effective means, whereas IS has the application portfolio of the entire firm as its responsibility. Therefore, for a number of reasons, IS would prefer to use the SDLC, an input-based control strategy, rather than an outcome-based control strategy, such as prototyping, that would shift the risk of requirements uncertainties to them.

A third and final proposition regarding systems development concerns the overall quality of systems built by end-users as opposed to those built by the IS department.

P3: Goal incongruencies between the central IS department and the end-user department and risk aversion on the part of the IS agent will cause end-user developed systems to be inconsistent with IS standards in areas like integration and quality.

In the issue of integration, the divergence in goals between user-developers and central IS is readily apparent. As the goal of central IS is to support the needs of the entire organization, the need for integration is clear and vital. Also, as a central provider of services, IS can exploit scale economies by developing policies and procedures that provide a consistent and integrated base, such as a central database, development platforms or interface standards. End-user departments may have neither the incentive nor the scale to

justify this type of effort. Moreover, with a centralized control mechanism, redundant efforts are less likely to occur, a result that is consistent with the goals of the organization.

This divergence of goals has been noted by several EUC researchers in terms of the lack of effort expended toward integration and coordination. For example, Guimaraes notes:

In the early stages of personal computing implementation, users often are preoccupied with operational problems and ignore managerial considerations. Consequently, problems with microcomputer compatibility have beset many of the users interviewed. (Guimaraes (1984), p.5)

Similarly, Alavi has observed:

The uncontrolled growth of microcomputers can lead to such difficulties as multiple versions of incompatible data and incompatible machines that can not easily be linked into networks...Uncoordinated proliferation of end-user tools (particularly microcomputers) most likely leads to difficulties in integrating and establishing communication links among these tools. (Alavi (1985), p. 17)

Another example of the likely lower quality of EUC-developed systems is the widely noted lack of documentation. Most observers of the EUC arena have noted this, for example:

In almost all cases, the necessary documentation and/or controls usually developed by I/S professionals for operational systems were lacking in the end-user developed systems. (Rockart and Flannery (1986), p. 307)

It was felt that the tendency of end-users to eliminate formal validation techniques, extensive testing, documentation and audit trails increases the data integrity and security risks. (Alavi (1985), p. 177)

To most personal computer users, "documentation" was an unknown word. (Benson (1983), p. 40)

This issue goes directly to goal incongruence. As noted by Rivard and Huff, the costs of the lack of these "systems hygiene" features are incurred by, and therefore are an issue to, the central IS agent, while the benefits accrue to the end-user. Conflict inevitably results:

Some users indicated that they did not document their applications and that they are the only ones who know how the applications work. However, this and other security and validity issues, such as the lack of audit trails, were mentioned by only 7.8% of the respondents, whereas DP professionals were quick to point to these as major problem areas. (Rivard and Huff (1985), p. 98)

Other related concerns expressed by DP managers included the lack of proper documentation, audit trails, and other operating controls...in user developed applications...any attempt to install rigid controls over UDA...would be self-defeating and probably impossible to implement...Unfortunately, all such efforts work against the primary critical success factor of UDA: the reduction of development time for smaller-scale, user oriented applications. (Rivard and Huff (1985), p. 101)

The lack of these features introduces risk to the central IS group, who may be called upon to take over operational responsibility for the end-user developed systems. In summary, these oft-cited deficiencies of EUC-developed systems are quite readily explained by self-interested behavior on the part of the principals and agents in the EUC systems development process.

C. Administration

The activities in Zmud's (1984) administrative category encompass those activities that constitute overhead and that provide long-term benefits, such as capital planning, budgeting and standards development. Many of the empirically recorded differences have been in such activities, particularly those that may be unobserved by users. In some cases, the activities may be observed by users, but are less valued by them than by the IS department. The agency model leads to the following proposition:

P4: Goal incongruence between the end-user organization and the firm as represented by central IS will cause EUC systems to be biased towards short term goals, which may be sub-optimal for the firm.

The EUC literature has long recognized that end-user developers are often in conflict with central IS. For example, consider this typical quote from an end-user developer: "When you develop applications yourself, you are the one who decides what is important. With DP, what is important for you is not important for them" (Rivard and Huff (1988) pp. 559). The essential tension in the relationship seems to stem from the end-user's preoccupation with the short term results of delivering the systems versus central IS's longer term view of how systems will need to be integrated and maintained. This conflict in orientation has been noted in several ways by Rivard and Huff:

Finally, because users spend little time on documentation and other "DP hygiene" factors, additional resources are saved (although the longer-term cost of such shortcuts may well outweigh the savings achieved)." (Rivard and Huff (1985), p. 101).

Others, however, recognized that the cost of the application they develop may not be lower for the organization as a whole. Because of their lack of expertise, users may take much longer than DP professionals to develop an application, and the program itself may be less efficient, less well documented, less well tested, etc." (Rivard and Huff (1988), p. 559)

Problems with integrating user developed systems with central IS systems or other user-developed systems generally surface later when there is a desire to expand the scope of successful user developed systems, either through added functionality or through making it available to other users. Initially, EUC developers need only support the narrow goals of their department, and the designs of such systems may prove to be poor platforms for expansion.

This short term orientation manifests itself in a number of ways. One piece of evidence is the differing attitudes toward quality:

A related concern involved the accuracy of the information produced by user-developed application. As Davis has pointed out..., many users are unable or unwilling to apply strict quality assurance to the applications they develop, leading to the likelihood of conflicting values for some of the company's key measures...Such problems are especially worrisome in cases of user-developed transaction processing applications, since these are most likely to become imbedded in a department's operating procedures. If they produce unreliable outputs, incorrect decisions may be made, possibly causing substantial harm to the firm. . . . Many DP managers reported a sense of frustration; while such errors would clearly be the user's "fault," as data processing professionals the DP managers know that they would also feel responsible." (Rivard and Huff (1985), p. 101)

This observation also highlights a dilemma faced by the IS department in reconciling local goals with organizational concerns.

A second commonly observed manifestation is the choice of development tools chosen by EUC developers, as witnessed by these observations from EUC researchers:

Otherwise, as was quite clearly occurring in many of the organizations we studied, users will stretch the available end user software products to do jobs in a manner far less efficient than could be done with the appropriate software. (Rockart and Flannery (1986), p. 305)

It also helps to explain our observation that many users would use a particular programming tool for a variety of different types of applications, in some cases applications for which the tool had clearly not been designed. Rather than invest more time to learn to use a new tool, users would make do with one they already know how to use though not well suited for the application at hand. (Rivard and Huff (1985), p. 100)

Finally, it is suggested that it may not be in the best interests of the firm to have, for example, marketing analysts developing systems that could be developed by central IS if the marketing analysts, in so doing, end up not doing their marketing tasks, but rather become involved in systems development. This over-involvement may be due to so-called "enrapturement" wherein the end-user becomes so involved and interested with the technology that he or she invests more time in the application than its business function would otherwise warrant (Waldman (1987)). In order to determine the most efficient approach from the organization's perspective, the opportunity cost of the users' time and the general loss that occurs due to the possibly greater total labor cost¹⁰ to the firm of this type of development is required. However, users may perceive EUC as personally more rewarding in terms of acquiring computer system-related skills to enhance their own worth in the job market at the expense of what the management of the organization might prefer.

Therefore, a short term orientation on the part of EUC developers is seen through many examples, including documentation, testing, integration, data integrity, tool choice, and task selection. This behavior is entirely consistent with that predicted by the agency model of EUC.

D. Operations/Technical Services

The third and final category involves operations and support of activities crucial to the successful continued operation of the IS function. For example, such activities as machine operation, hardware maintenance, systems software maintenance, and database support are included here. The essential unifying concept behind these activities is that the

¹⁰ Individual compensation is obviously an important variable in this calculation.

traditional centralized IS department provided support for a whole set of shared resources, such as the mainframe and its supporting software, and the organization's database. Many of the observed behaviors involved in the migration from traditional computing to EUC can be seen to stem from the agency relationships involving end-users and central IS. In particular, the agency model suggests the following proposition:

P5: Goal incongruencies between the central IS organization and the end-user organization will cause the end-user organization to treat shared resources as a free good.

Even as firms evolve from the traditional centrally-developed, centrally-operated systems to EUC-developed systems, these new systems often continue to be run on the existing central computing resources. This may be due to a number of reasons, including excess capacity on the central (typically mainframe) resource, insufficient demand to merit departmental machines, or simply a desire by IS to retain decision rights within the central IS organization. No matter what the reason, a commonly-observed phenomenon is that end-users tend to overconsume these shared resources. In the case of hardware resources, this is often due to their choice of operationally inefficient fourth generation languages.

Witness the following comments from EUC researchers:

The primary issue of concern to MIS/DP managers was inefficient applications created by end-users (mentioned by 59% of the managers). Where corporate mainframe computers are used for support of EUC activities, inefficient and unplanned growth of end-user applications may overtax the computer resources. (Alavi (1985), p. 177)

...respondents indicated that the programs they write are not as efficient as those written by DP professionals. This is also a concern of many DP managers. (Rivard and Huff (1985), p. 98)

Few users are concerned about machine or operating inefficiencies...User computing is characterized by a frequently careless user attitude toward system operational efficiency. Inefficient use of the mainframe is expected eventually to become a major problem for MIS departments. (Guimaraes (1984) pp. 5-6).

Users are willing to pay significant hardware running cost premiums to get systems up and running quickly under their control. (Rockart and Flannery (1983))

Agency costs can again be seen as a fundamental cause of the problems observed in practice with end-user systems development. The costs of operational inefficiency are often borne by central IS as they are called in to re-write the system, or they must justify to top management the need for larger operational capacity for the inefficient applications. Additionally, it is during the re-writing that some of the problems of lack of documentation and other shortcuts are discovered. Thus the end-user often does not bear the true cost of these inefficiencies and, instead, imposes externalities on central IS.

It could be argued that this is an entirely rational attitude by users, in that hardware unit costs are rapidly declining and that efficient development will economize on expensive labor at the expense of saving mainframe cycles. This rational explanation is unlikely to be the case in EUC for two reasons. The first is that it is not uncommon for users not to be charged at all for this usage, leaving them with little information for making such a decision. For example, at one site Rivard and Huff note that

When the Information Center was introduced at firm A, it was decided that users should not be charged so that they would be encouraged to use the... services and tools. Since they did not have to pay for the services, users were not motivated to determine the cost effectiveness of the applications they developed, and no mechanism existed to formally require users to assess the cost effectiveness of their applications. (Rivard and Huff (1984), p. 47)

In fact, users were not charged at all in forty percent of the sites investigated by Rivard and Huff, ((1984), p. 45). A second reason for doubting this explanation is that this EUC overconsumption behavior is observed on resources other than mainframe hardware cycles. For example, Guimaraes has observed the following behavior on IS support resources:

Indeed, the level of personal computing usage appears to be inundating MIS departments with requests for assistance in dealing with technical problems that users are apparently unable to tackle on their own. (Guimaraes (1986), p. 182).

Rivard and Huff noted a similar problem with decentralized hardware: "Even then, some users indicated that having to share a workstation was sometimes a problem" (Rivard and Huff (1985), p. 100). Therefore, it seems that these inefficient user-written programs

reflect self-interested behavior on the part of users, minimizing their own investment at the expense of firm-wide shared resources and of central IS.

From this examination of the EUC empirical literature, it has been shown that the wide range of observations often analyzed through ad hoc models developed for the EUC phenomenon can be readily explained through the use of the agent-theoretic model. In the next section, a set of managerial and research recommendations are made based on the agency approach.

5. MANAGERIAL IMPLICATIONS AND CONCLUDING REMARKS

Organizations are increasingly seeking managerial strategies that will increase the effectiveness of information technology. The management of these information systems is a difficult task, challenged with balancing the divergent interests of many user groups in the face of rapid technological change. IS managers are confronted with the sometimes contradictory tasks of encouraging users to utilize newer technologies to derive additional benefits while ensuring that their use is cost-effective. In addition, such actions may diverge from an IS manager's personal agenda of increasing his or her span of control. It is, therefore, not surprising that IS departments are often unsuccessful in meeting the stated needs of their users.

Given the existence of decentralized computing and the trends in the technology, the theory provides insights into the appropriate division of IS activities between end-user departments and the IS department. It suggests that IS activities that experience large economies of scale or specialization relative to the cost of externalities should be centralized. These activities may include the use of large mainframes, telecommunications services and site licensing. On the other hand, if an activity is of relevance only to a single end-user department, the department manager should be free to determine how such a task is implemented. Perhaps most importantly, however, given the existence of interdependencies among most computing applications, a primary role of the IS

organization must be to develop enforceable policies and standards that ensure that the costs to an end-user of developing computing applications or of using computing resources reflect the true organizational costs, including the costs of externalities.

Beyond these prescriptions, the agency EUC model presented in this paper is a positive model that helps to explain the widespread occurrence of decentralized computing. In the absence of appropriate control mechanisms, end-users are likely to have opted for decentralized computing. Decentralization allows these users to make resource allocation decisions, including software and hardware acquisition decisions, and to develop implementation and operations schedules that are consistent with their self-interests. As discussed earlier, earlier IS environments were characterized by economies of scale and specialization in production that have decreased over time. An end-user manager would, therefore, have sought the decentralized solution at that point in time where the marginal costs of the externalities incurred plus the marginal costs that derive from loss of control over the information resource equal the decreasing marginal benefits of the economies of scale and specialization.

Agency theory provides a valuable framework with which to analyze these managerial actions in the context of EUC. It highlights the possible differences in the goals of the IS manager, end-user managers and top-level managers, and it emphasizes the role of the differences in information possessed by each of these groups. These factors necessitate the implementation of control strategies that economize on agency costs. Agency theory suggests that these strategies focus on two major aspects of the control problem, the informational aspects and the incentive aspects.

One approach to addressing the existing information asymmetries is to increase the level of monitoring to improve the information that the principal possesses. However, the nature of information asymmetries in the IS context limits the value of monitoring as a means to reduce agency costs. For example, the output of an IS department is difficult to measure, the value of IS activities to users is similarly difficult to estimate, and the rapid

pace of technological change makes it difficult to monitor the quality of decision-making by an IS manager.

An alternative approach is the use of incentive-compatible schemes that align the incentives of principals and agents. These schemes are designed in a manner such that agents are provided with incentives to provide accurate information. It is assumed that each agent possesses private information about his preferences and that he is self-interested. The objective is to achieve the optimal allocation of resources under these information asymmetries and goal incongruencies. These mechanisms typically involve a central planner who elicits information from agents and then determines a schedule of prices. Since it is virtually impossible to force agents to reveal their true valuations, the fee schedule is designed in a manner by which agents find it in their best interests to reveal their true valuations. A well-known example of such a scheme is the Clarke-Groves-Loeb (1971, 1975) (hereafter CGL) tax mechanism. While there has been considerable focus on these schemes in the economics literature, relatively little work exists in the IS context. Work on the design of incentive-compatible schemes in the IS context is due primarily to the work of Mendelson and Whang.¹¹ Their work has focused primarily on the optimal allocation of mainframe resources under queuing delays.

The CGL scheme could also be applied to other IS management issues. For example, consider the software acquisition decision where there are multiple user departments and several competing software packages. Each department manager is asked how much he or she is willing to pay for each package. For example, assume that there are three managers and three software packages, as shown in Table 5.1.

¹¹ See Mendelson (1985), Whang (1988), Mendelson and Whang (1989), and Whang (1989).

Manager	PACKAGES			TAX
	A	B	C	
1	50	20	0	30
2	0	60	20	0
3	40	0	50	30
TOTAL	90	80	70	60

Table 5.1 DIFFERENTIAL VALUES OF SOFTWARE PACKAGES

The total value of each package is computed by summing over each manager's stated value for that package. The package that receives the highest total score is acquired. The key to ensuring that the managers reveal their true valuations is the chargeback mechanism. The difference between the values associated with any two packages is the dollar amount that a particular manager would be willing to pay to have the package with the higher value than the one with the lower value. By summing any particular column, total values for each package can be determined. In the example, package A is highest valued. The taxes can be computed by systematically determining the resulting outcome absent each one of the managers. These results are shown in Table 5.2. For example, if manager 1 is excluded, then package C would have been selected by a difference of \$30 (70-40). Hence manager 1 would be taxed \$30, since it was due in part to his or her valuation that package A rather than C was chosen. The surcharge, or tax that Manager 1 pays, is the price for the privilege of determining the package eventually chosen. On the other hand, Manager 2 would not be taxed, since package A would still be chosen without taking his or her preferences into consideration. Finally, Manager 3 would be taxed \$30 (80-50), since package B would be selected if Manager 3 abstained from the process.

	A	B	C
Without Manager 1	40	60	70
Without Manager 2	90	20	50
Without Manager 3	50	80	20

Table 5.2 TOTALS WITHOUT EACH MANAGER

Despite this literature in economics, the design of contracts to minimize agency costs that result from actions taken by the IS manager do not appear to have received any attention in the IS research and management literatures. There are a number of reasons why this might be the case. In addition to the lack of IS research attention to this area, these schemes are sometimes difficult to implement. Moreover, IS activities are so varied that significant effort would be required to develop schemes that would address the multiple tasks¹². Finally, the impacts of managerial actions in the IS context have not been well understood, and only now are managerial practices beginning to stabilize (Nolan (1979), Gurbaxani and Mendelson (1989)). Indeed, there is still considerable variance in managerial opinion related to such issues as the choice of organization structure for the IS department (Swanson and Beath (1988)) and even to the institution of chargeback systems (Allen 1987).

This paper has proposed that agency theory provides a useful framework within which to analyze managerial decision-making in the IS context. It has shown that the widespread growth of EUC can be explained, in part, by the existence of agency costs in the IS environment. In addition, the agency model suggests that the use of incentive-compatible schemes can be used to decrease agency costs and improve the management of

¹² Banker and Kemerer (1989) have recently developed a model of multi-criteria performance evaluation in the IS context.

validation of the theory, and more formal hypothesis testing using primary data is a desirable next step. Future research using agency theory is likely to be successful both in explaining other observed phenomena and in developing better control mechanisms.

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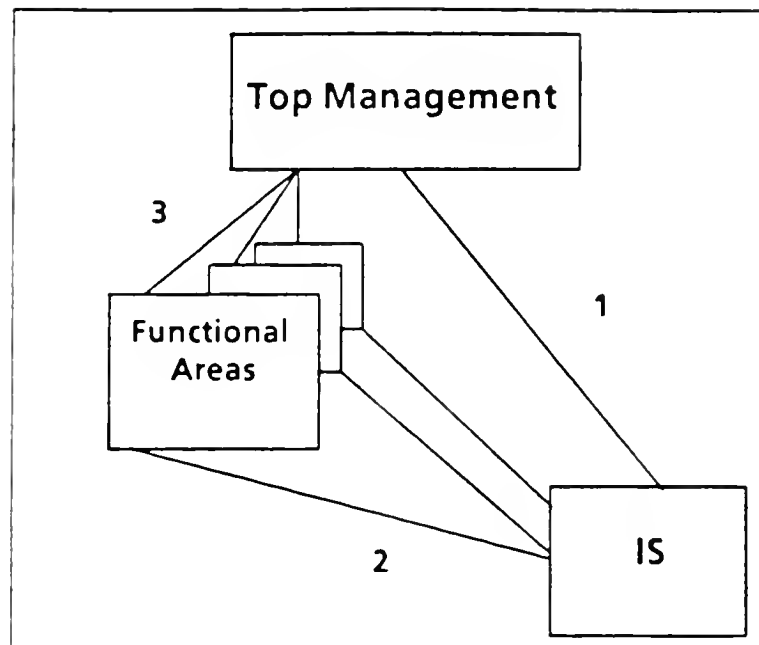


Figure 1. Agency Relationships

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